Initial trace gas measurements from the Global Hawk Whole Air Sampler during ATTREX – Nov. 2011

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R. Hendershot, S. Gabbard (NCAR)

Objectives

- Decrease uncertainty in the bromine budget in the UT/LS.
  - Measurement of a complete suite of organic bromine compounds
  - Define composition of halogenated trace gases entering stratosphere
- Examine transport rates and mixing processes
- Understand sources of trace gases/aerosols in the UT/LS
- Characterize variability and distributions of short-lived gases in the UT/LS

	Yrs	Source
Chlorofluorocarbons		
CFC-11	50	A
CFC-12	102	A
CFC-113	85	A
CFC-114	300	A
CFC-115	1700	A
Halons		
CFC-12b1 (Halon 1211)	20	A
CFC-13b1 (Halon 1301)	65	A
CFC-114b2 (Halon 2402)	20	A
Hydrochlorofluorocarbons/ Hydrofluorocarbons		
HCFC-22 (CHF2Cl)	13	A
HCFC-141b (CH3CFCl2)	9.4	A
HCFC-142b (CH3CF2Cl)	19.5	A
HFC-134a (C2H2F4)	14	A
HFC-152a (C2H4F2)	1.5	A
Solvents		
Carbon Tetrachloride	40	A
Methyl Chloroform	4.8	A
Tetrachloroethylene	0.3	A
Methylene Chloride	0.3	A
Chloroform	0.4	A/ N
Trichloroethylene	0.02	A
Methyl Halides		
Methyl Bromide	0.8	A/N/B
Methyl Chloride	1.5	N/B
Methyl Iodide	0.01	N
Methylene Bromide	0.4	N
CHxBryClz	0.1	N
Bromoform	0.1	N

	Yrs	Source
Organic Nitrates		
Methyl nitrate(CH3ONO2)	0.08	A/N
Ethyl nitrate(C2H5ONO2)	0.04	A/N
Propyl nitrates(C3H7ONO2)	0.03	A/N
Butyl nitrates (C4H9ONO2)	0.02	A
Non-Methane Hydrocarbons		
Ethane (C2H6)	0.2	A
Ethyne (C2H4)	0.06	A/B
Propane(C3H8)	0.04	A
Isobutane(C4H10)	0.02	A
n-Butane (C4H10)	0.02	A
Isopentane (C5H12)	0.01	A
n-Pentane (C5H12)	0.01	A
Isoprene (C5H10)	hrs	N
Benzene (C6H6)	0.04	A/B
Toluene (C7H8)	0.01	A/B
Other		
Methane (CH4)	9	A/N/B
Carbon Monoxide (CO)	0.4	A/N/B
Nitrous Oxide (N2O)	115	N
Carbonyl Sulfide (COS)	30	N/A/B
Dimethyl Sulfide (C2H6S)	<.01	N

A = anthropogenic/industrial

N = natural/marine

B = biomass burning

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HFC-152a (C2H4F2)	1.5	A
Solvents		
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Methyl Chloroform	4.8	A
Tetrachloroethylene	***0.3***	***A***
Methylene Chloride	0.3	A
Chloroform	0.4	A/ N
Trichloroethylene	0.02	A
Methyl Halides		
Methyl Bromide	0.8	A/N/B
Methyl Chloride	1.5	N/B
Methyl Iodide	0.01	N
CHxBryClz	0.1	N

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Isopentane (C5H12)	0.01	A
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Isoprene (C5H10)	hrs	N
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Carbon Monoxide (CO)	0.4	A/N/B
Nitrous Oxide (N2O)	115	N
Dimethyl Sulfide (C2H6S)	<.01	N

A = anthropogenic/industrial

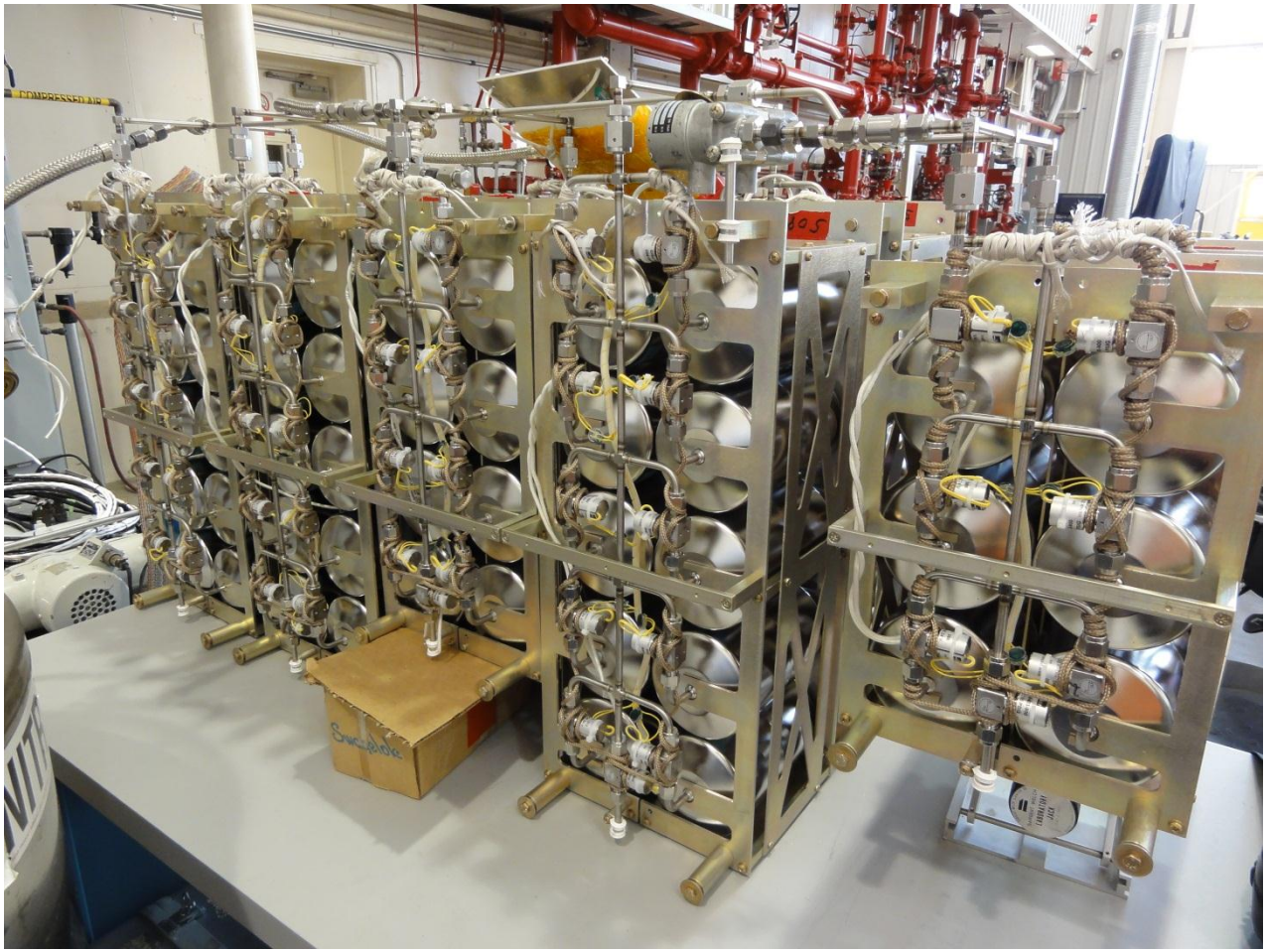
N = natural/marine

B = biomass burning

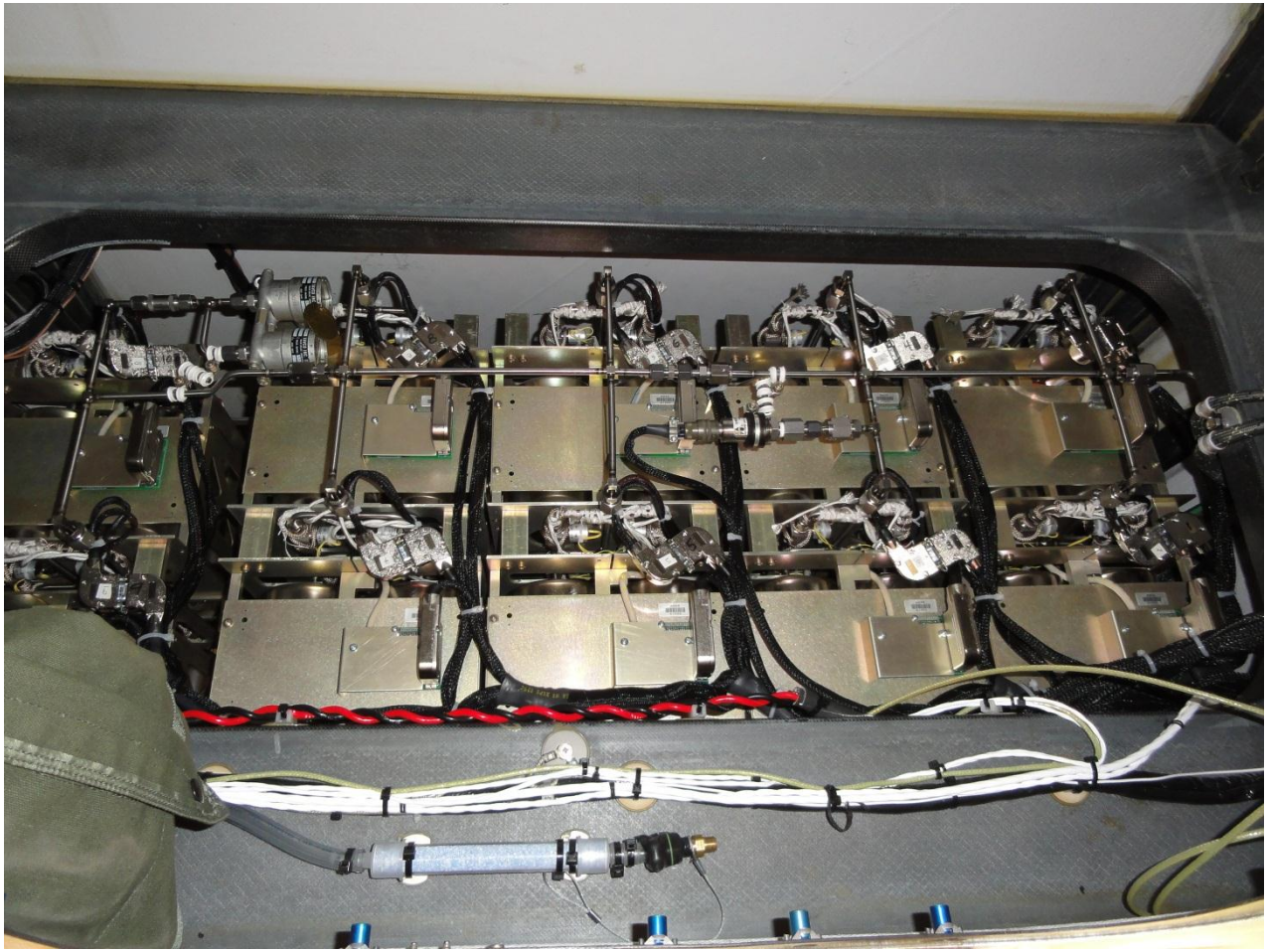
UM/NCAR Whole Air Sampler

- 90 samples/flight
  - 7 x 10 sample + 1 x 8 sample + 2 x 6 sample modules
- New canisters/valves/manifold design/control system
- Fill times
  - 14 km 30 – 40 sec
  - 16 km 40 – 50 sec
  - 18 km 50 – 60 sec
  - 20 km 100 – 120 sec (estimated)
- Analysis in UM lab: GC/MS; GC/FID; GC/ECD; GC/RGD

AWAS modules (top view)

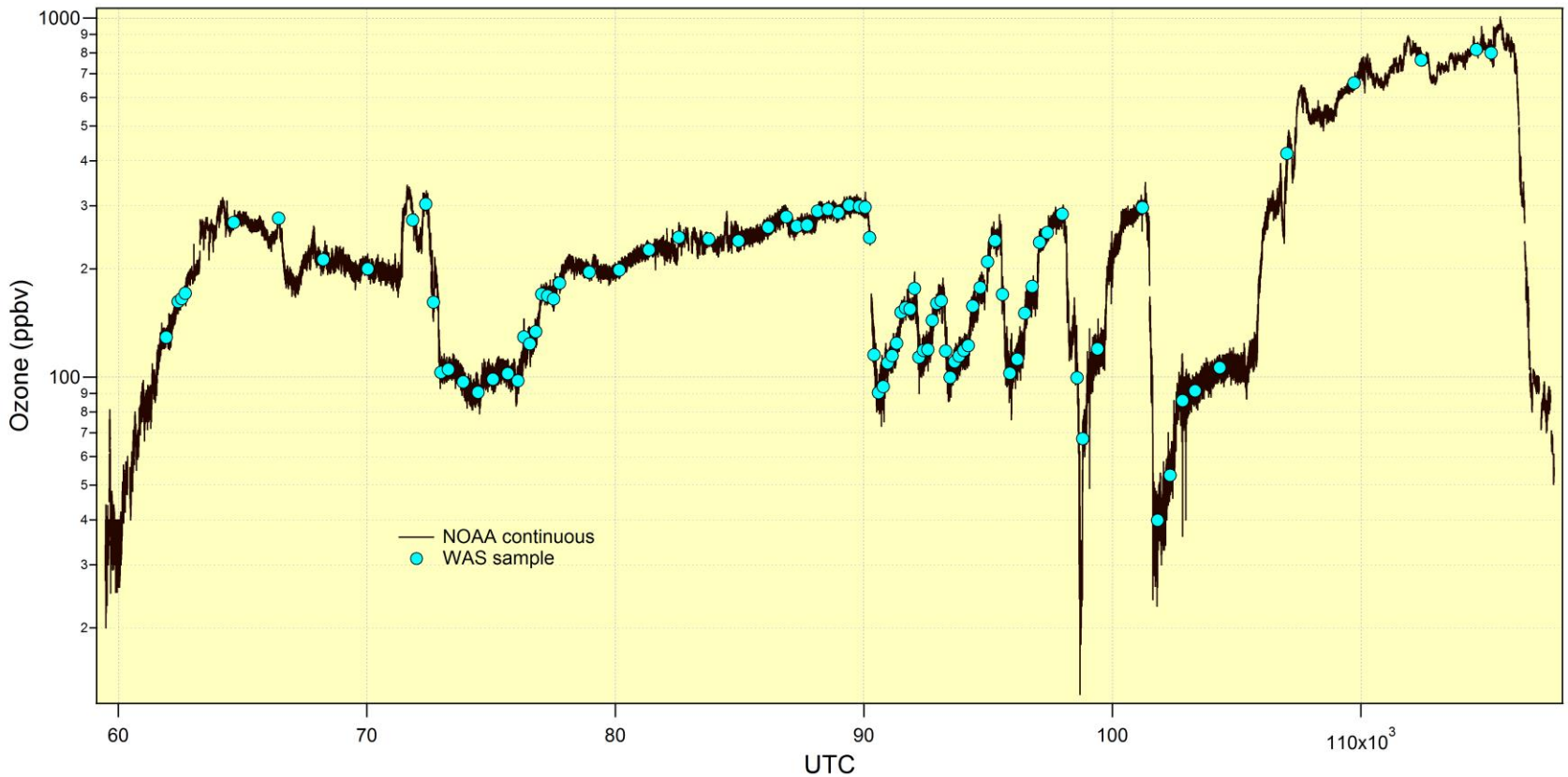


AWAS installed in GH Area 61



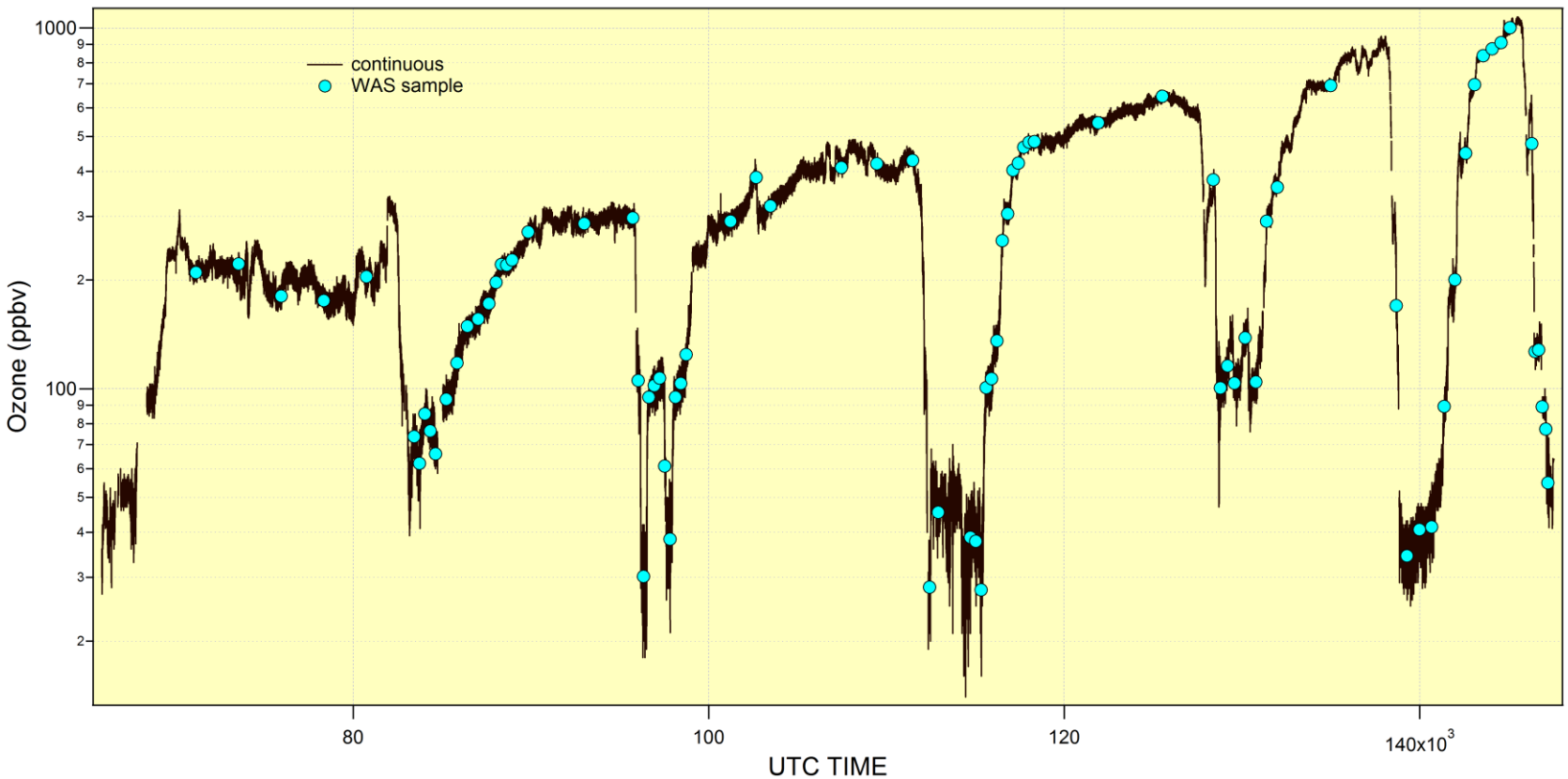
NOAA Ozone + AWAS sample times

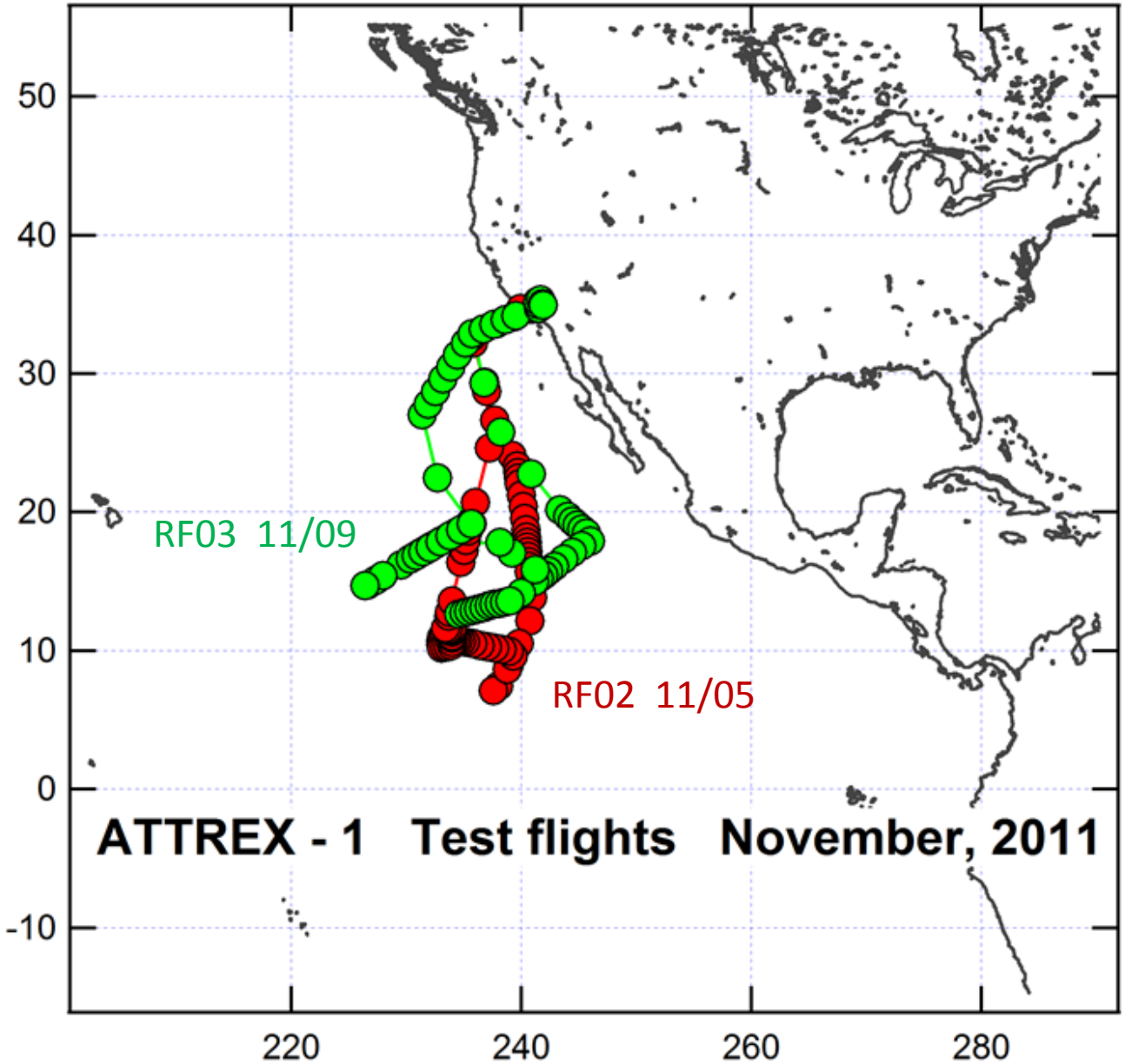
RF 02 2011_11_05

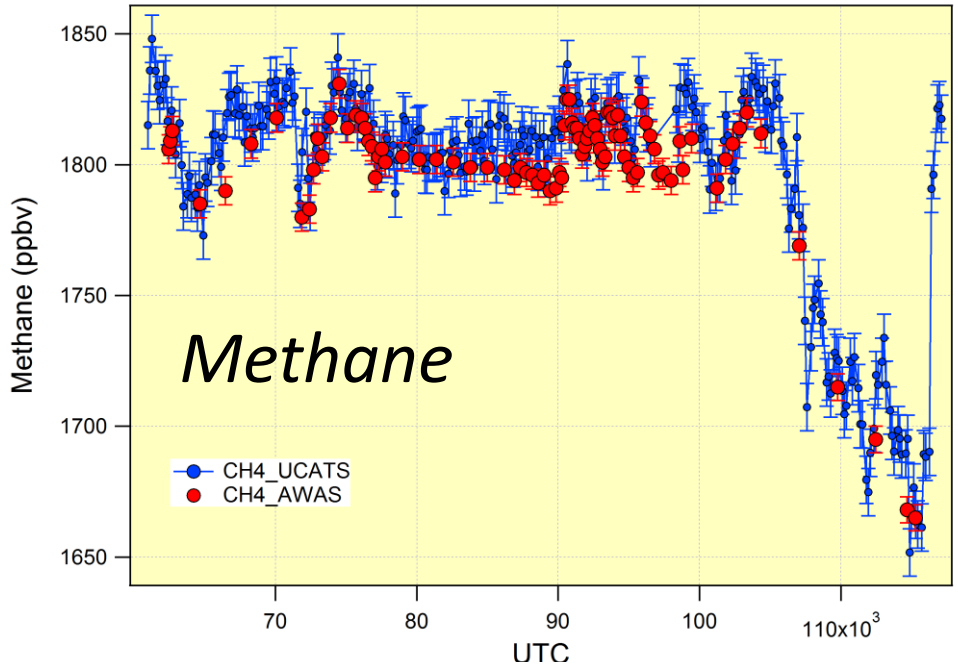


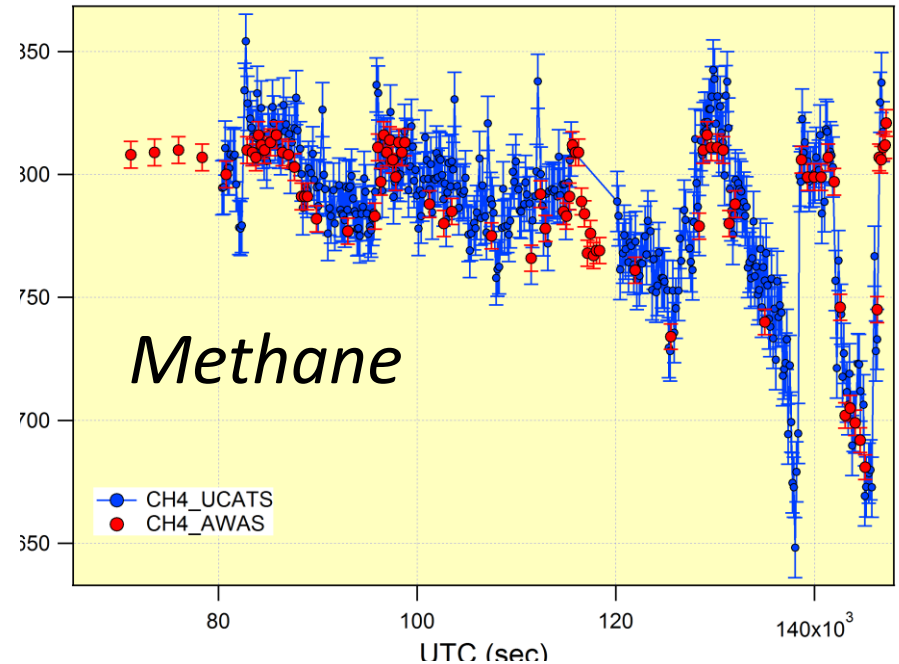
NOAA Ozone + AWAS sample times

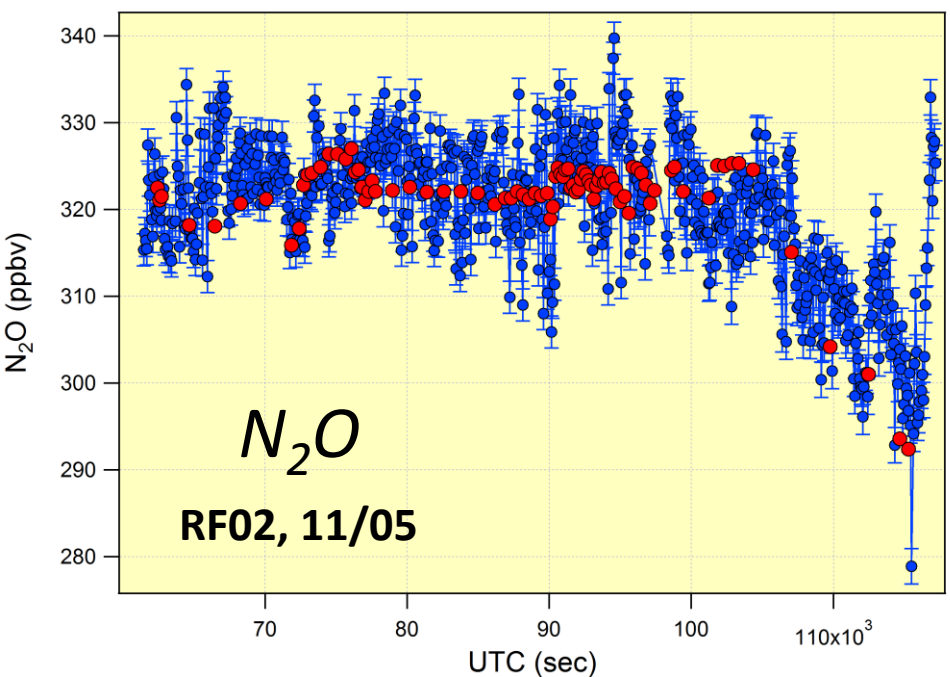
RF 03 2011_11_09

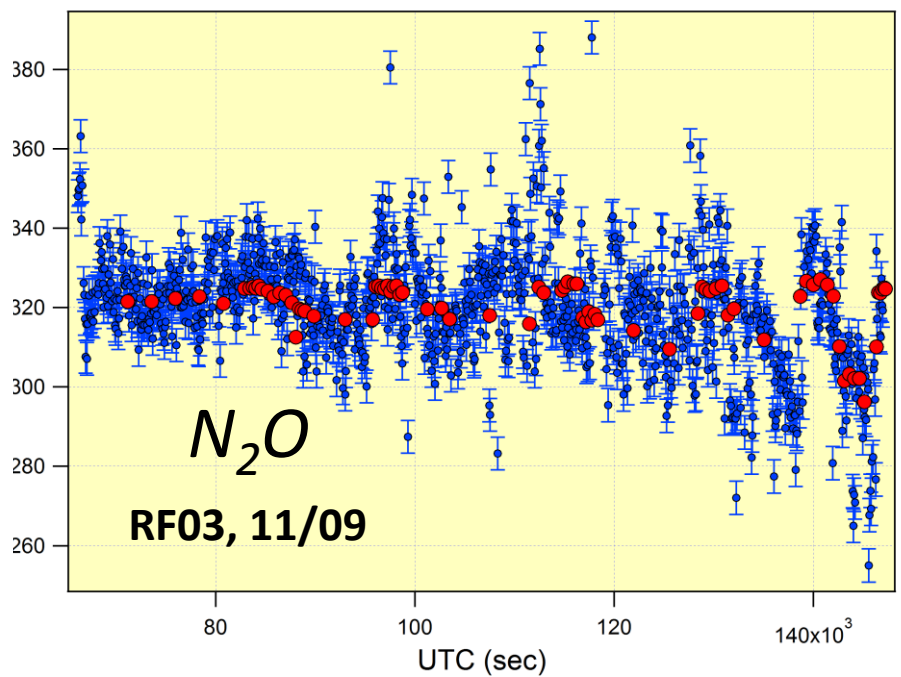



50
40
30
20
10
0
-10
220
240
260
280
RF03 11/09
RF02 11/05
ATTREX - 1 Test flights November, 2011

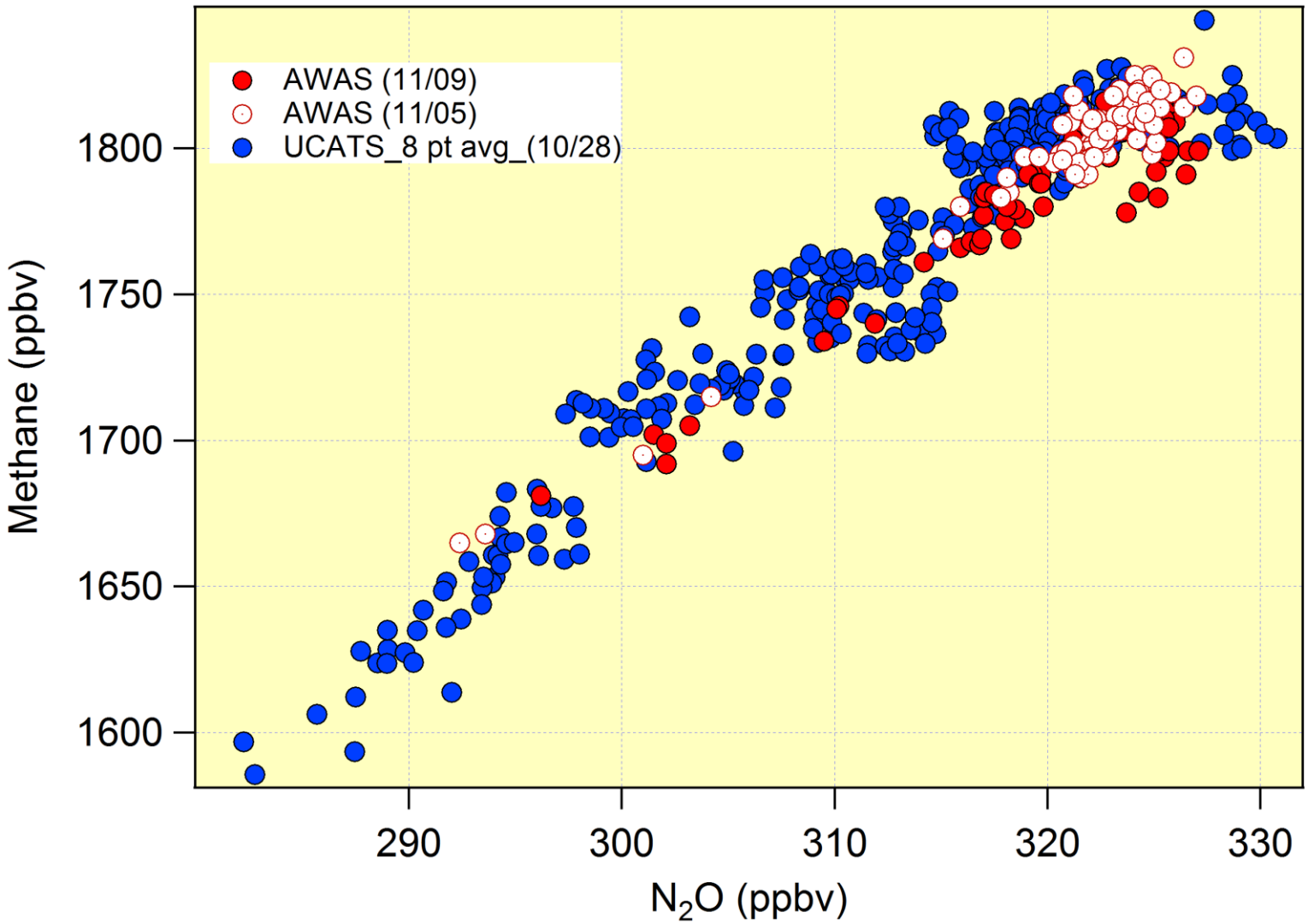

Methane
CH4_UCATS
CH4_AWAS
Methane (ppbv)
1850
1800
1750
1700
1650
70
80
90
100
110x10^3
UTC

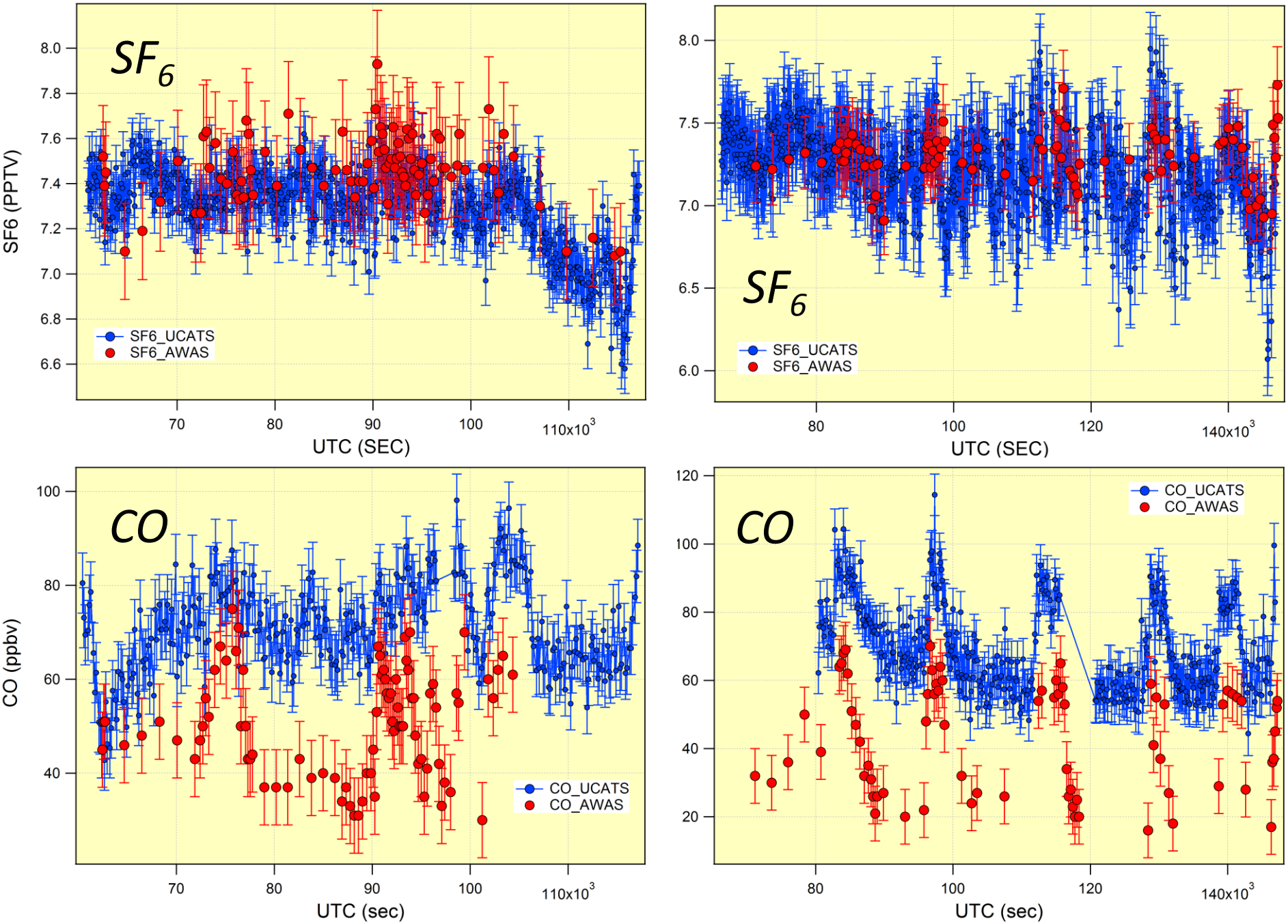

Methane
CH4_UCATS
CH4_AWAS
80
100
120
140x10^3
UTC (sec)


N2O
RF02, 11/05
N2O (ppbv)
340
330
320
310
300
290
280
70
80
90
100
110x10^3
UTC (sec)

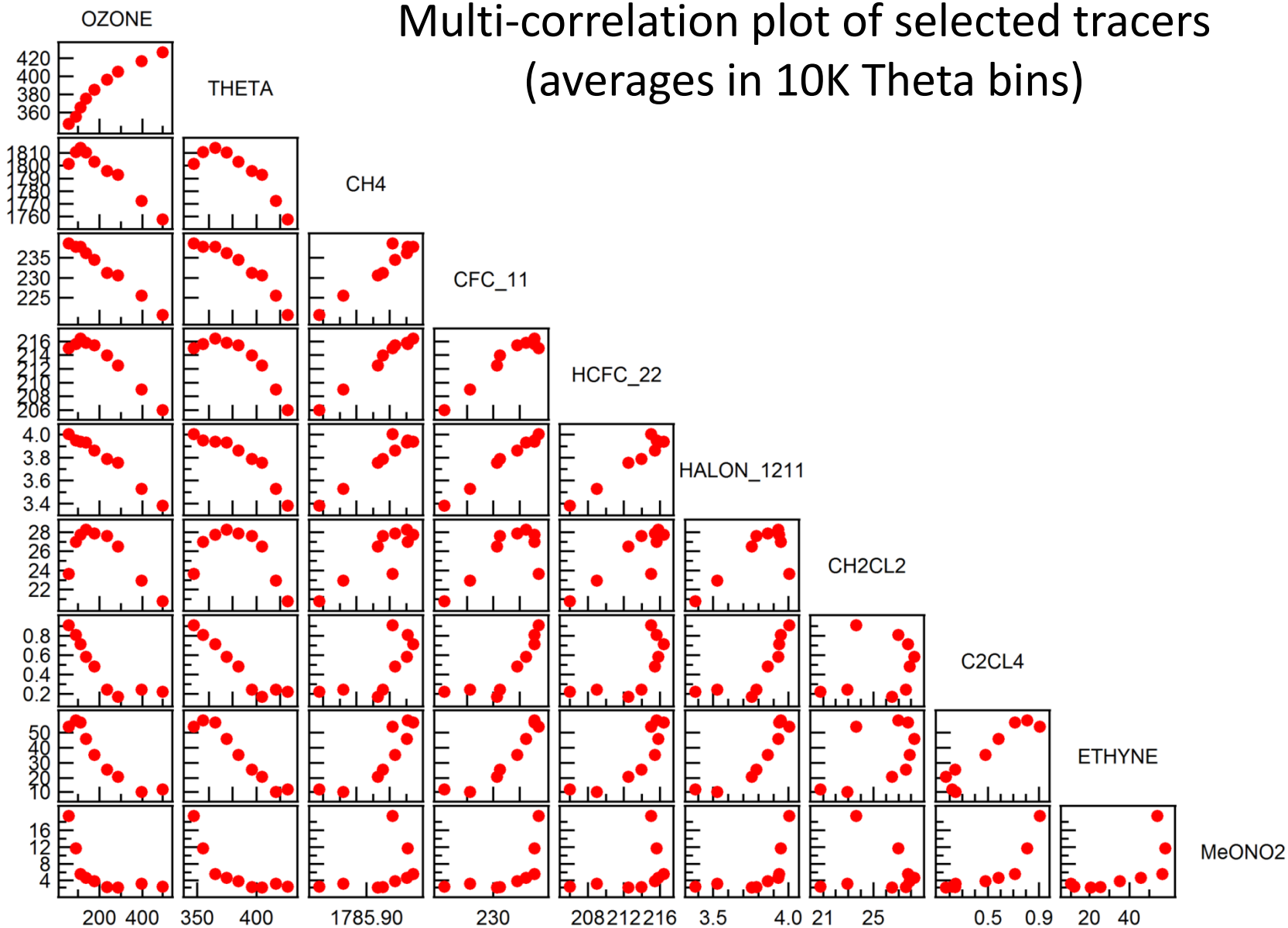

N2O
RF03, 11/09
380
360
340
320
300
280
260
80
100
120
140x10^3
UTC (sec)

Methane:N_2O UCATS (avg) & AWAS

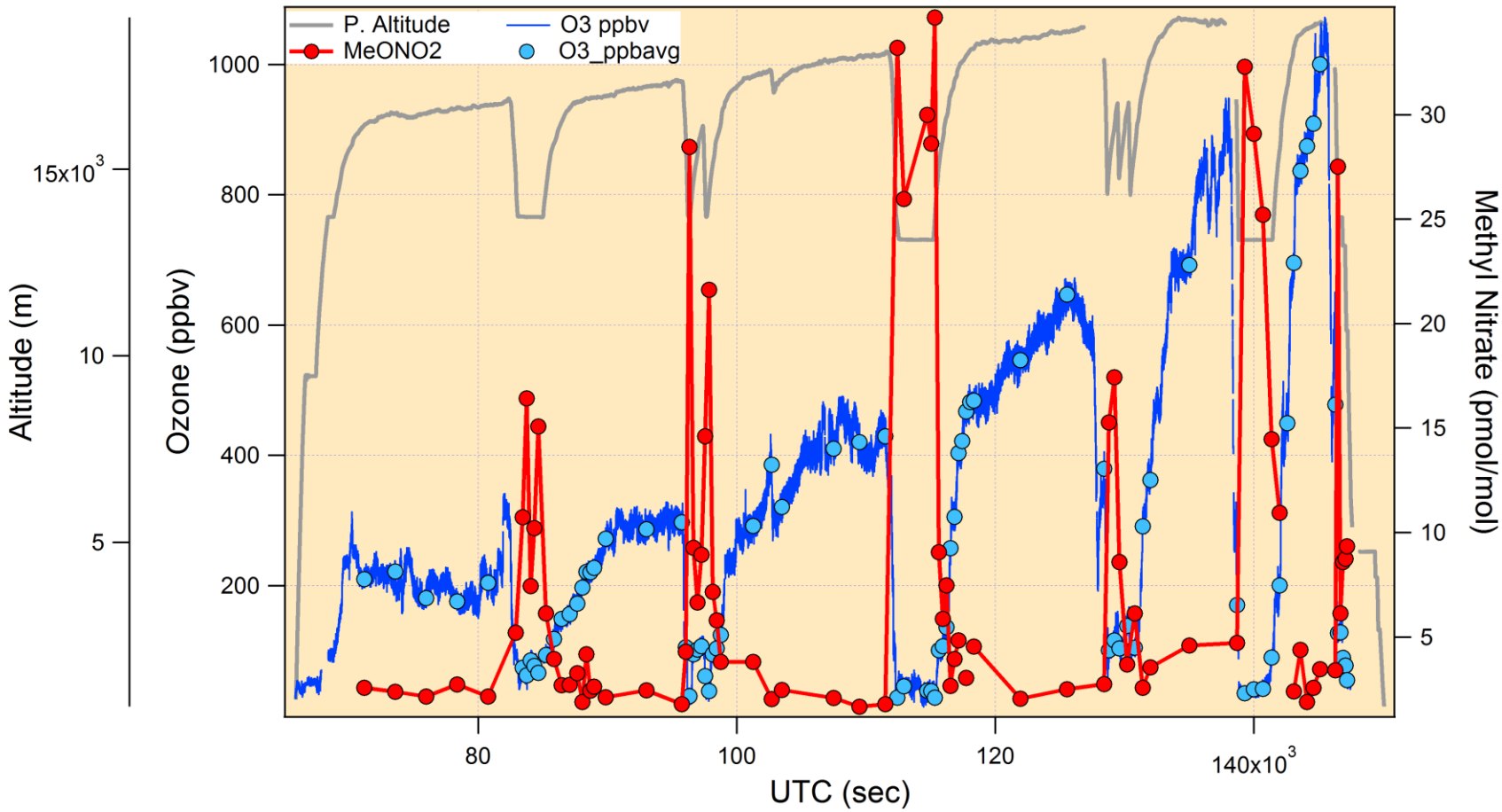



SF6 (PPTV)
SF6_UCATS
SF6_AWAS
UTC (SEC)
110x10^3
140x10^3
CO (ppbv)
CO_UCATS
CO_AWAS
UTC (sec)

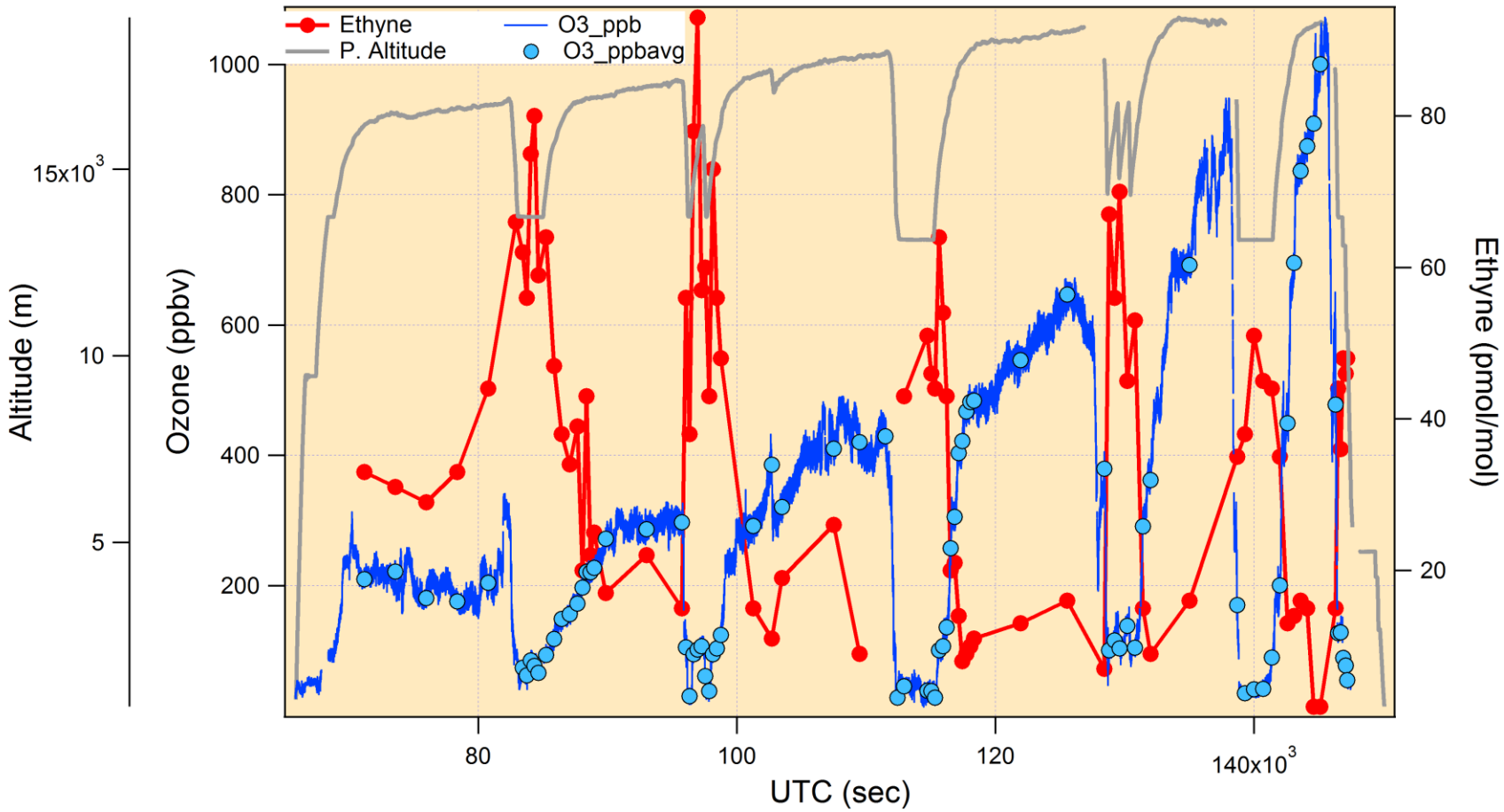
Multi-correlation plot of selected tracers (averages in 10K Theta bins)



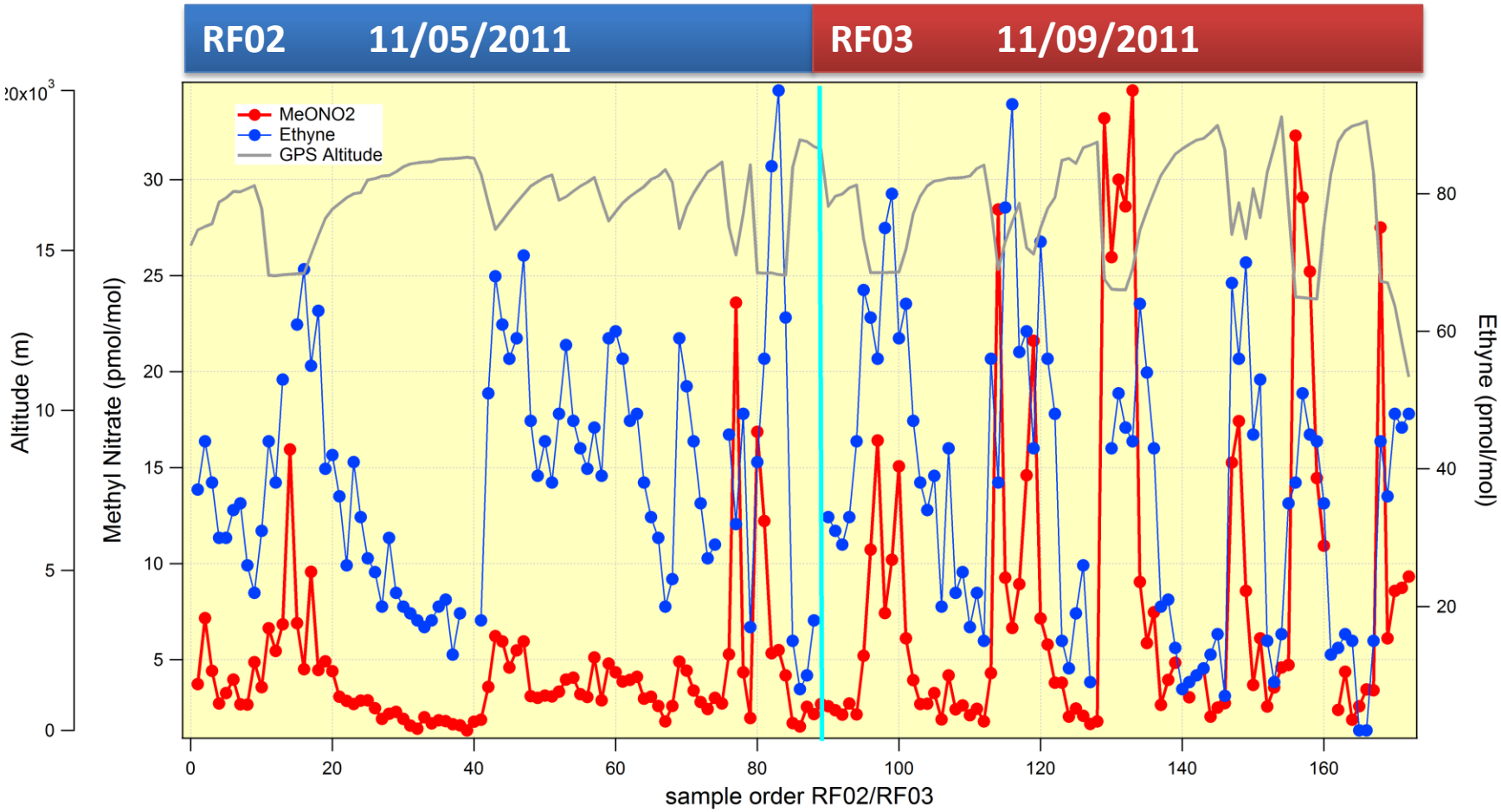
RF03 Time Series: Ozone, Methyl Nitrate



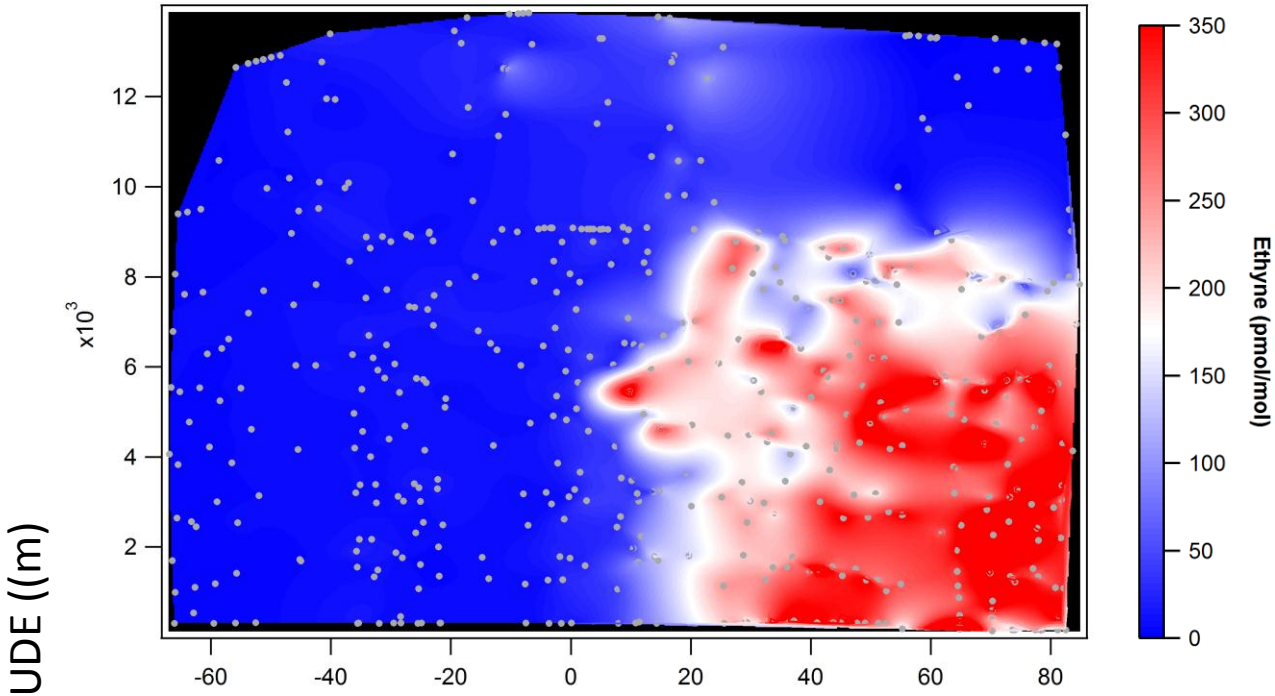
RF03 Time Series: Ozone, Ethyne



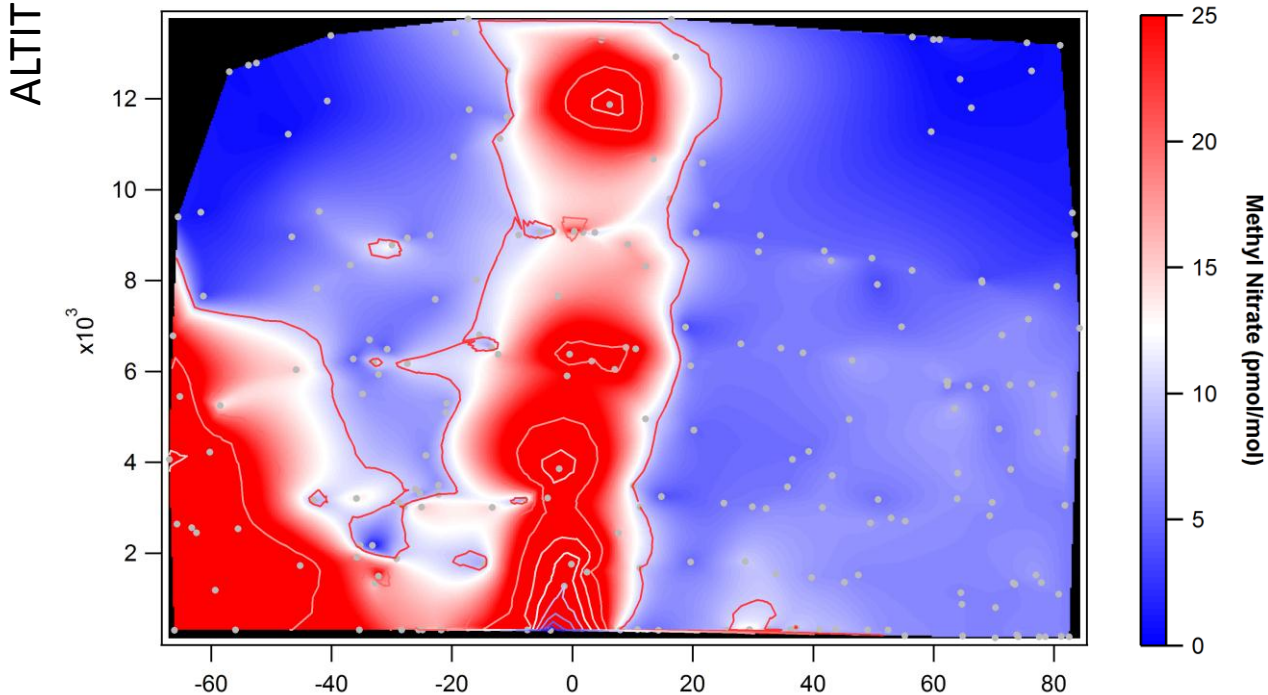
Time Series: Ethyne, $MeONO_2$



HIPPO-3 (NOV., 2009)

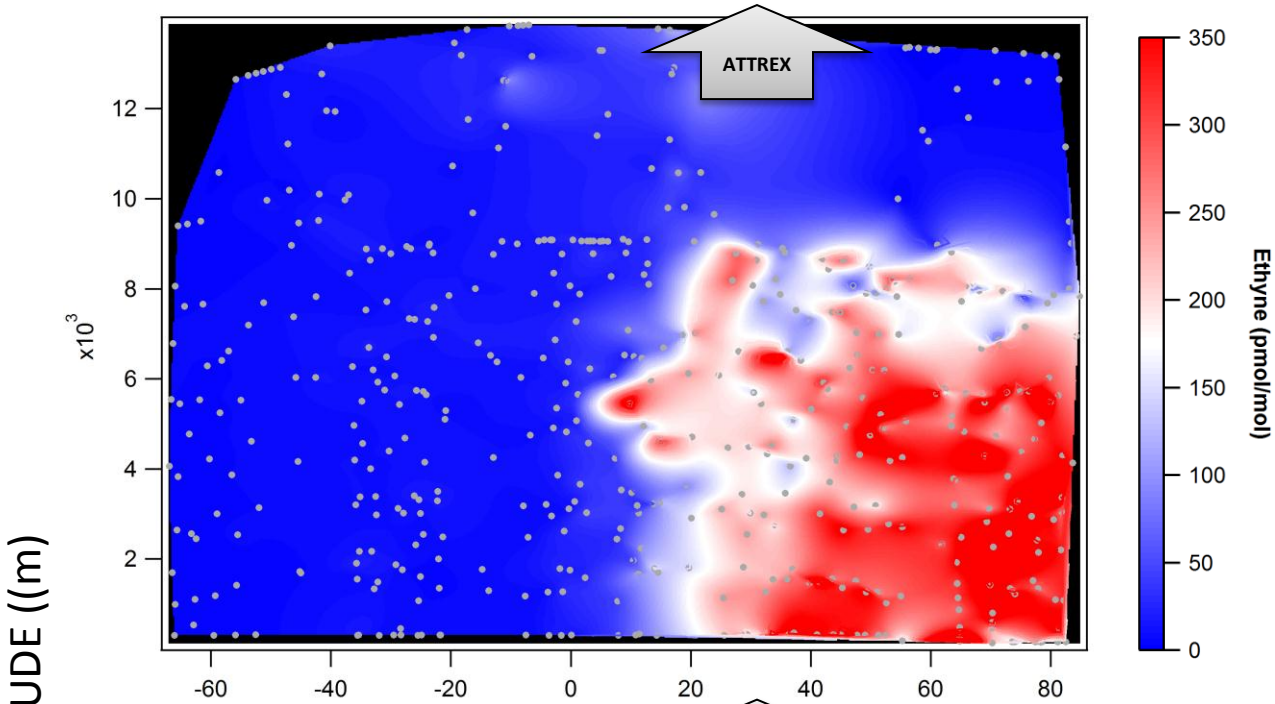


Ethyne

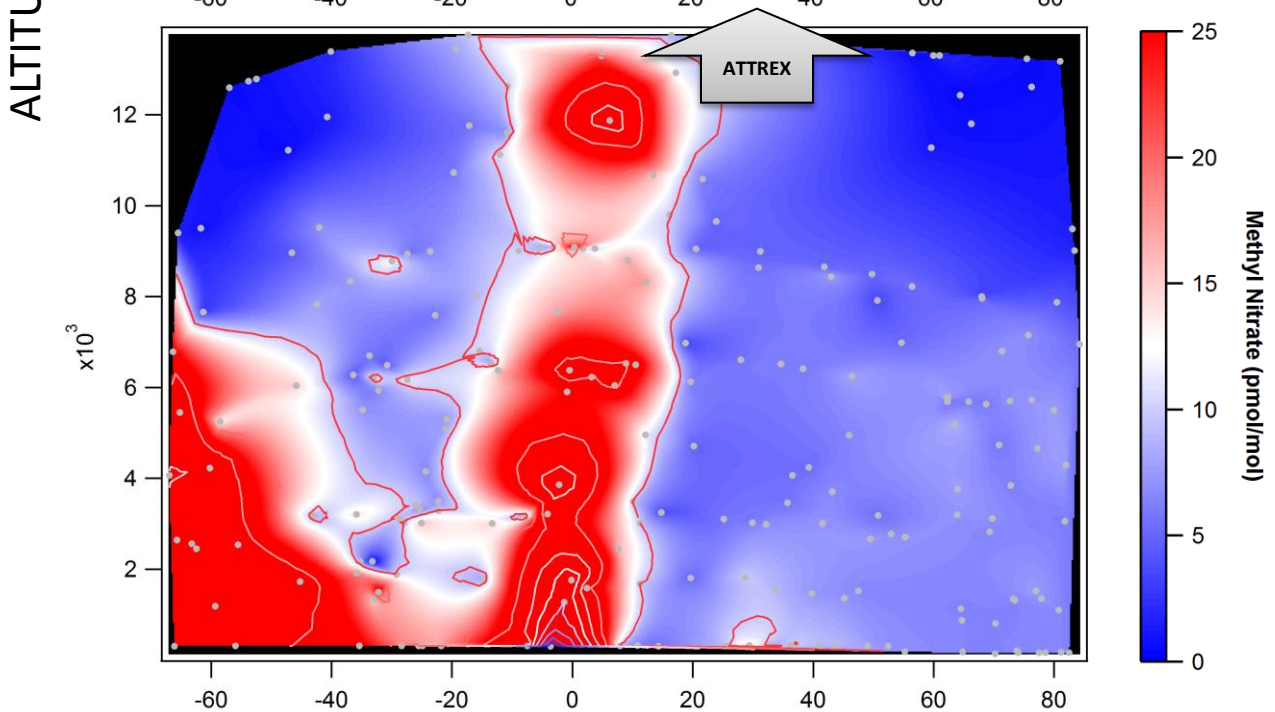


Methyl Nitrate

HIPPO-3 (NOV., 2009)

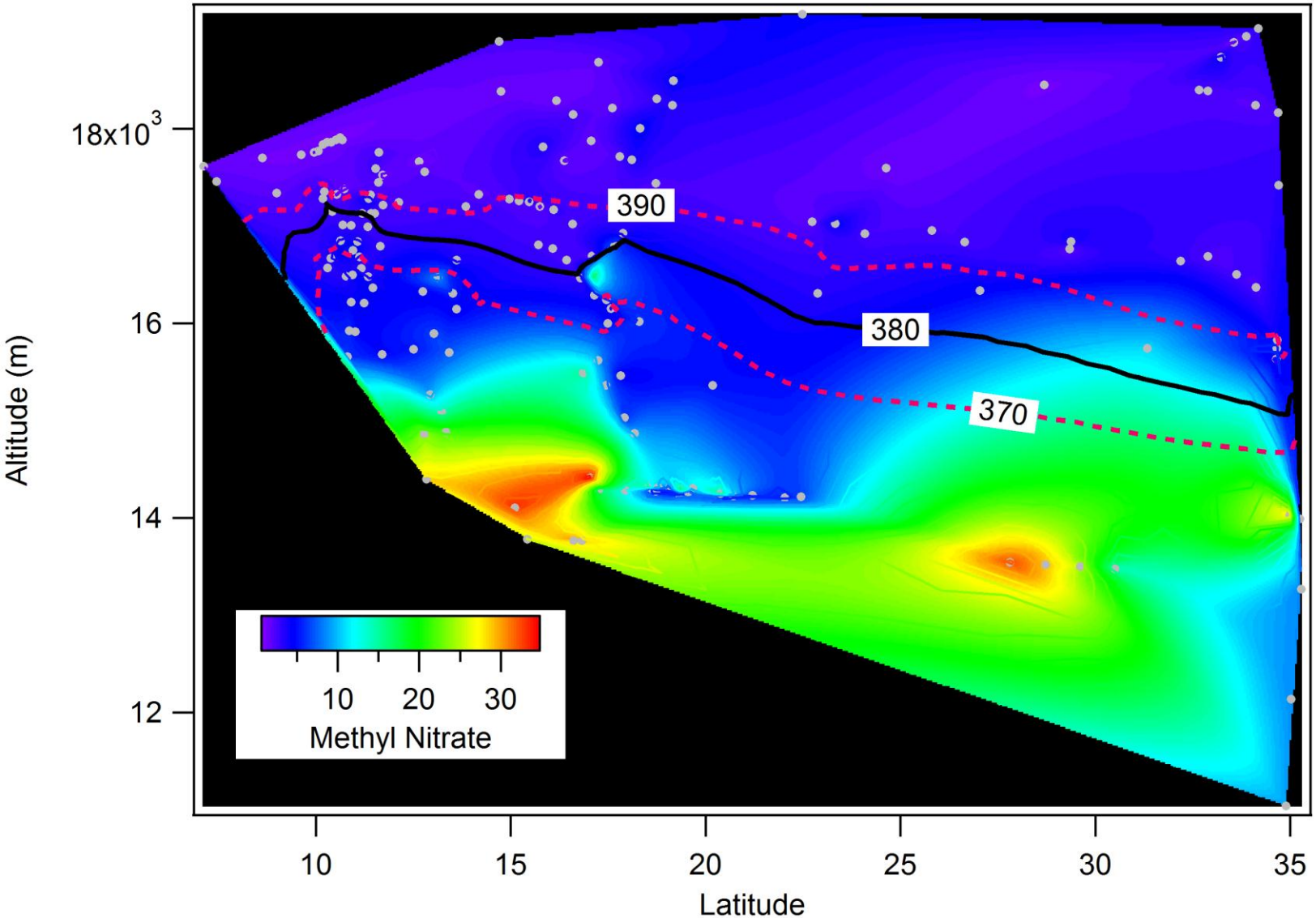


Ethyne

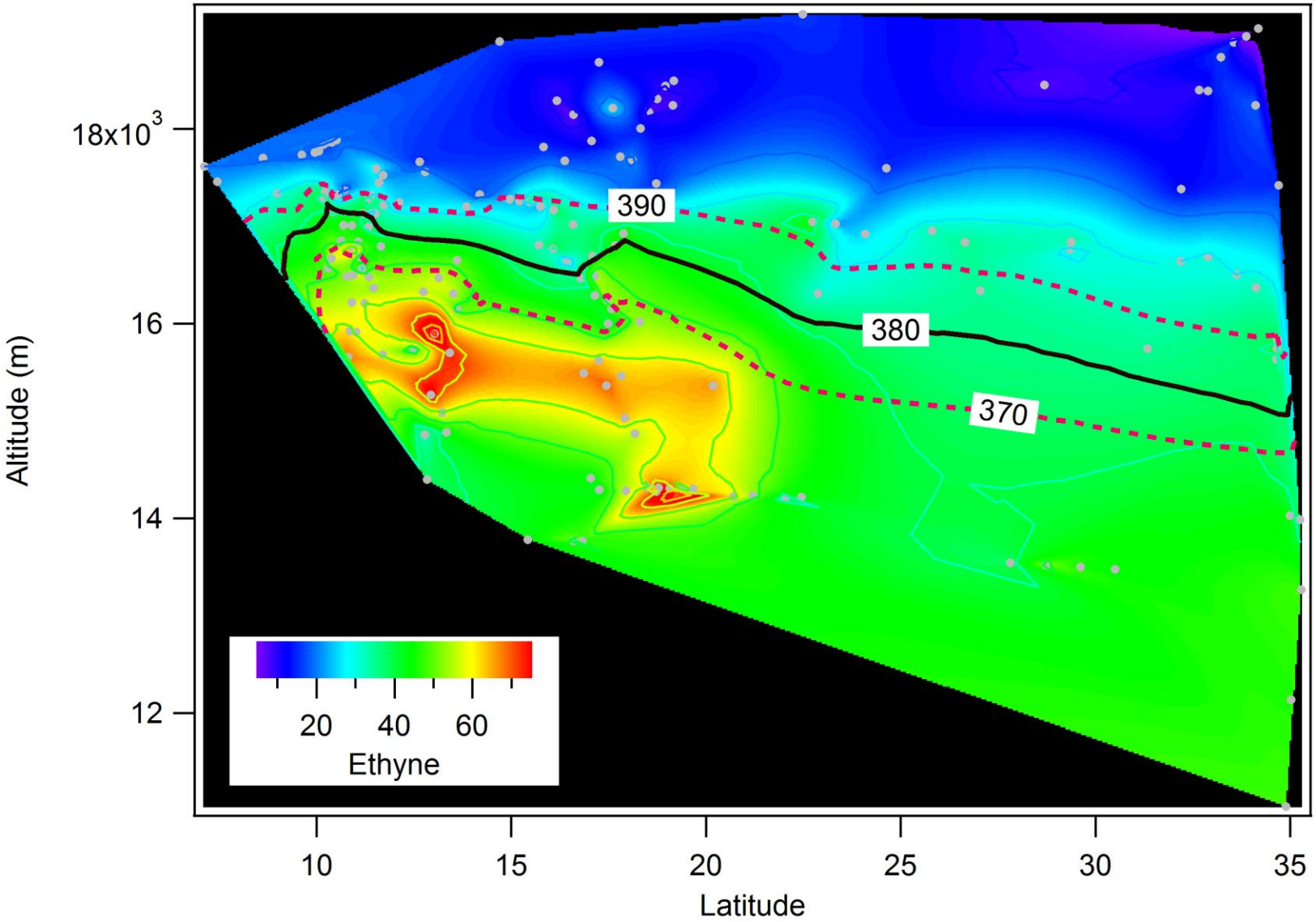


Methyl Nitrate

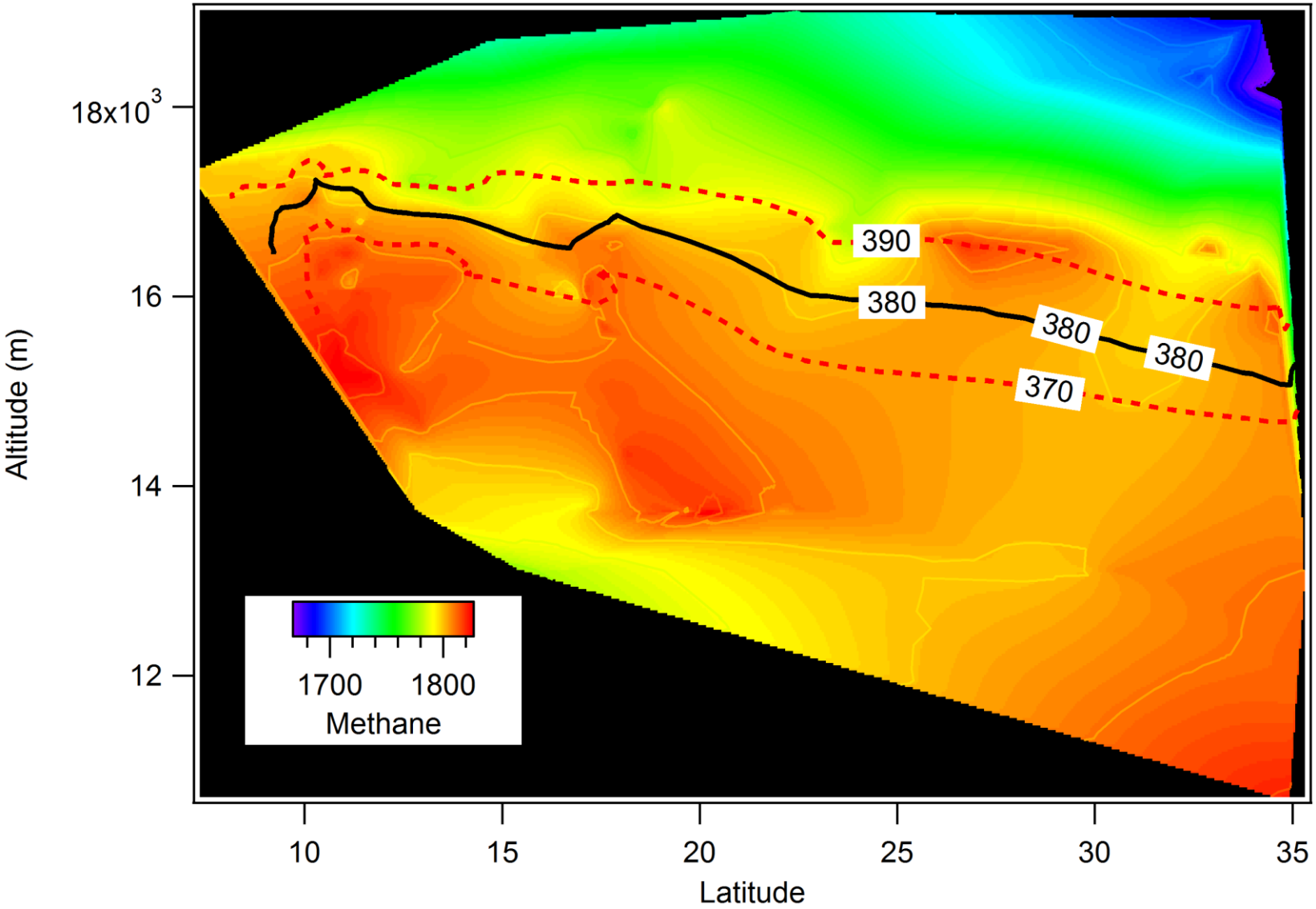
Methyl Nitrate



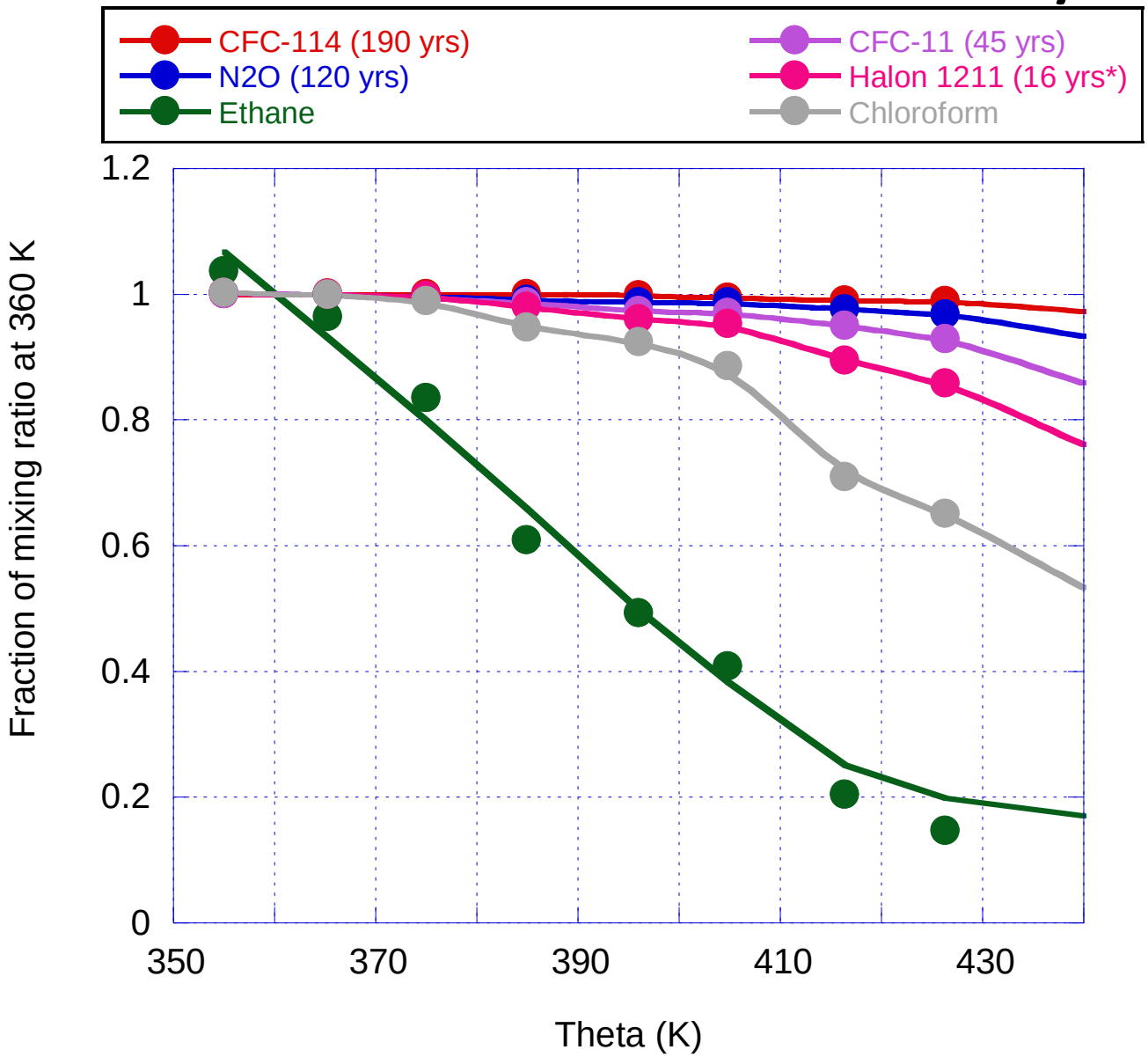
Ethyne


18x10^3
16
14
12
Altitude (m)
390
380
370
20
40
60
Ethyne
10
15
20
25
30
35
Latitude

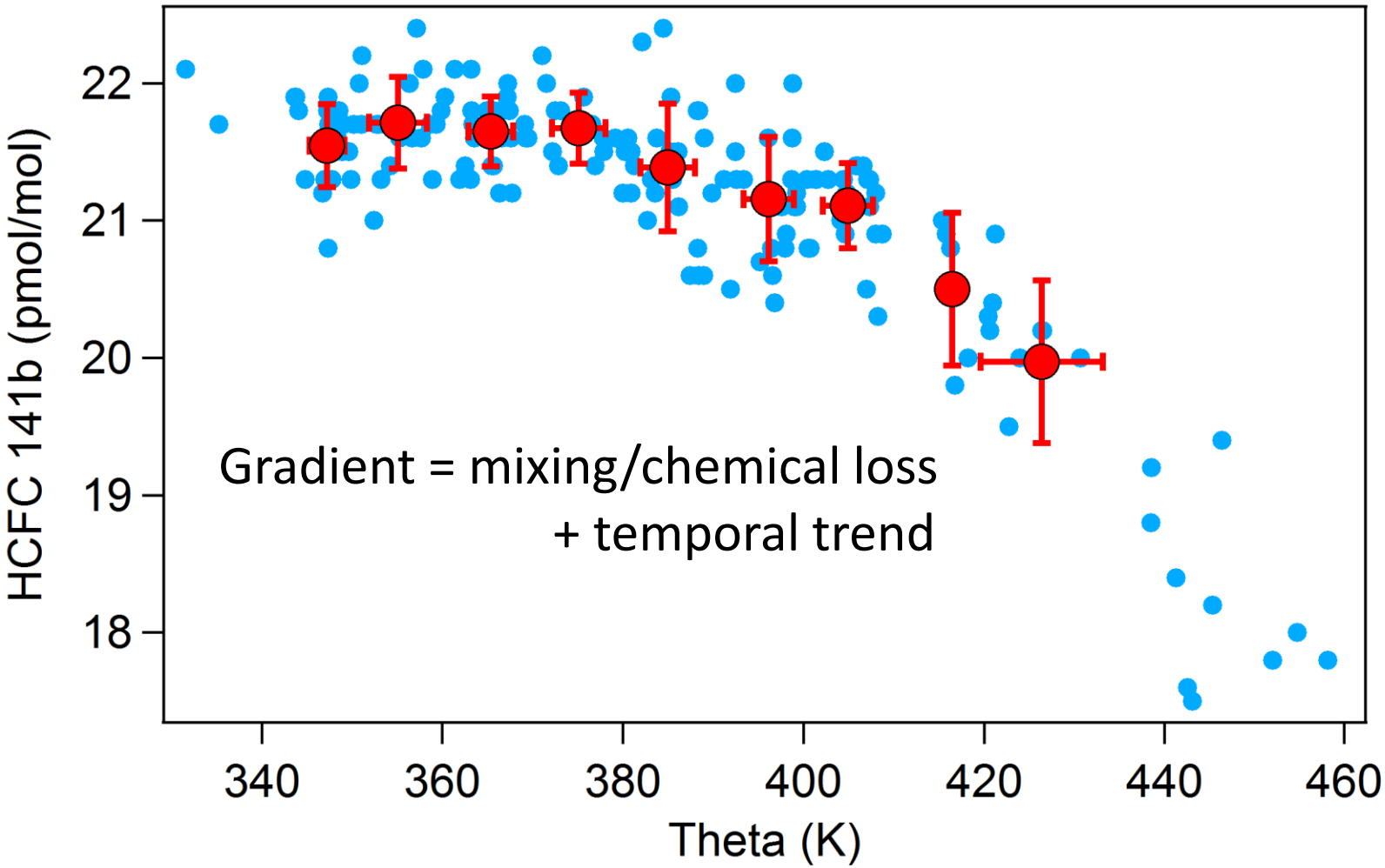
Methane


18x10^3
16
14
12
Altitude (m)
390
380
380
380
370
1700
1800
Methane
10
15
20
25
30
35
Latitude

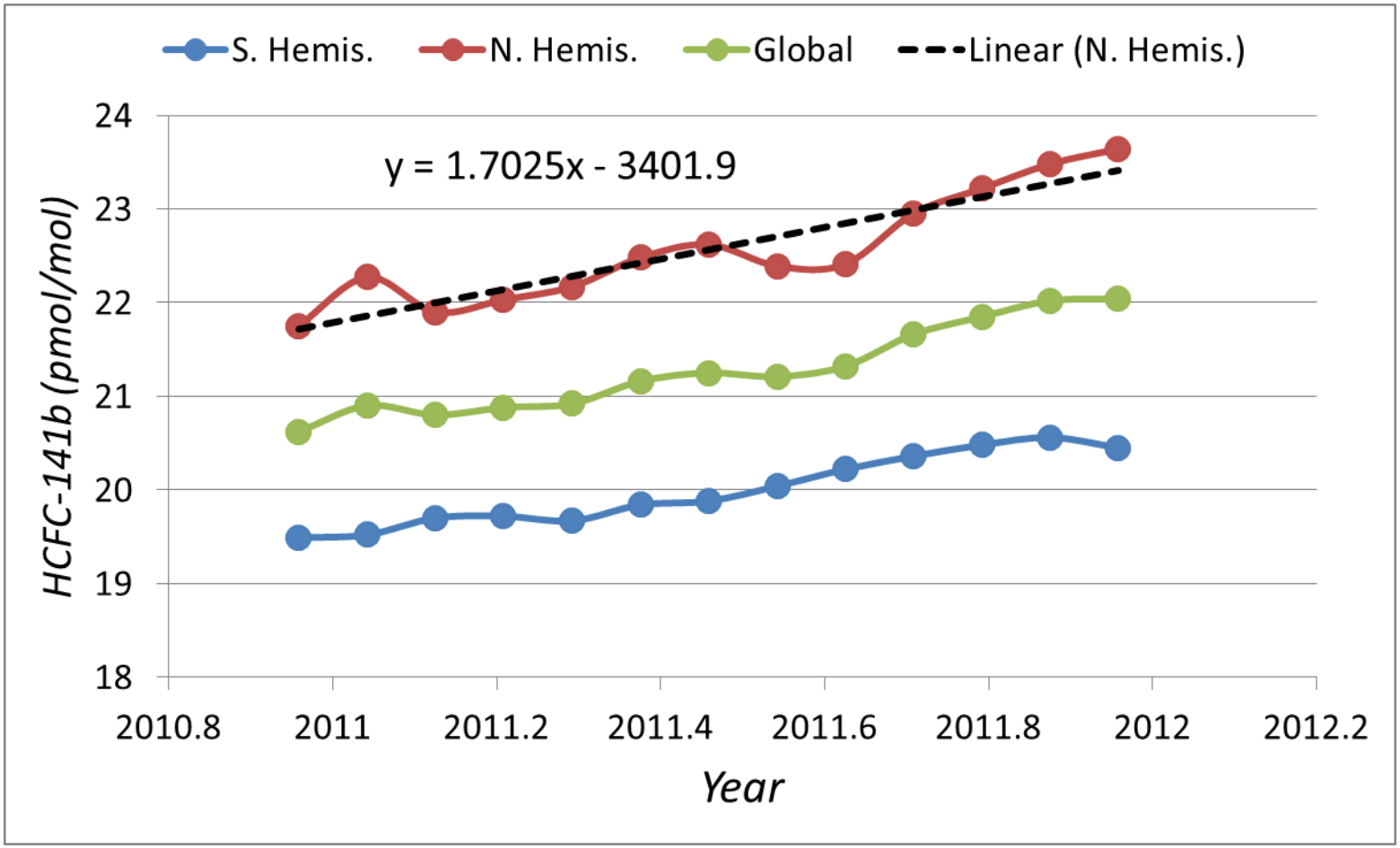
Chemical Gradients in UT/LS



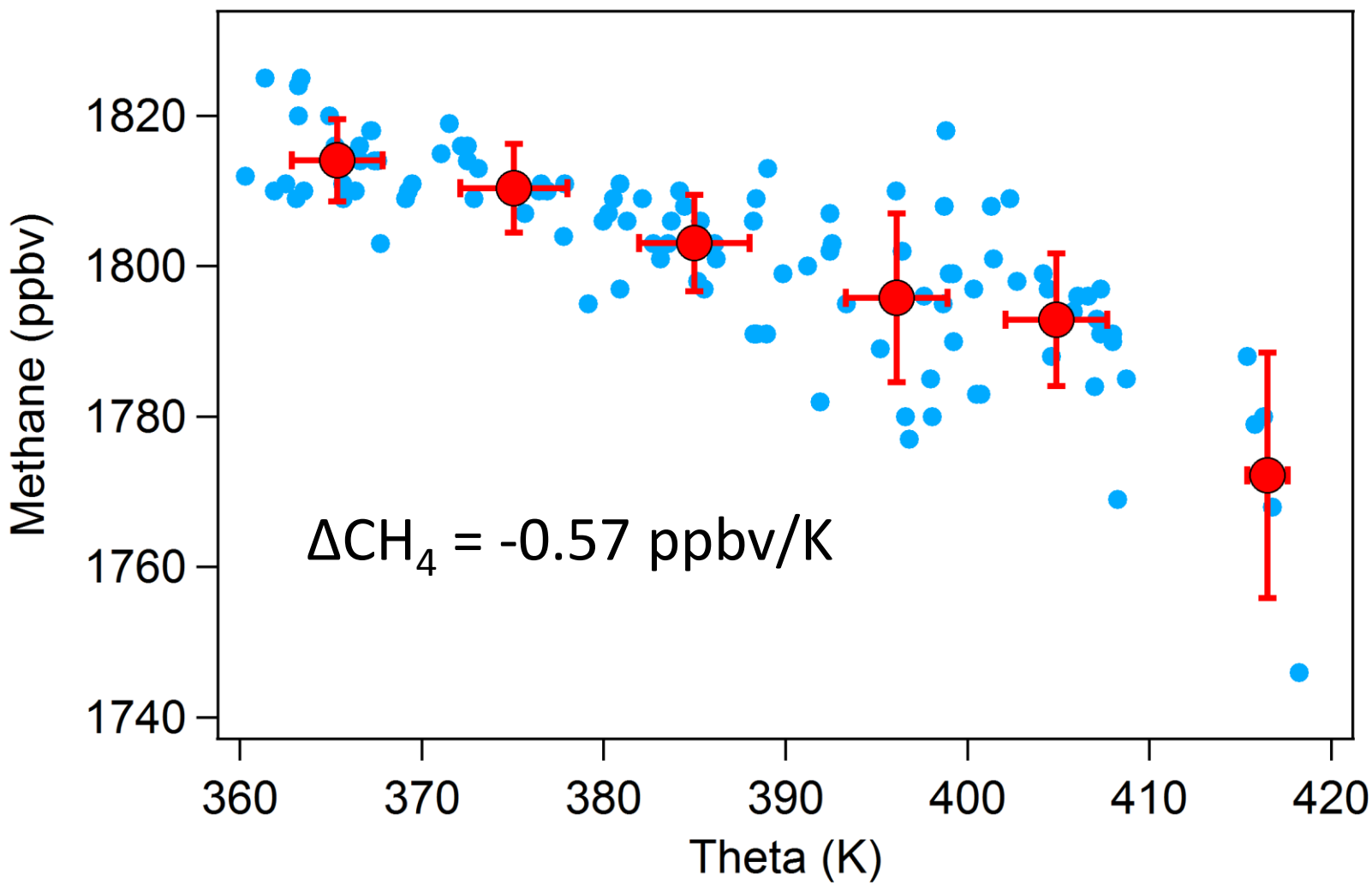
Chemical gradients in TTL



HCFC-141b Recent Trend (from Montzka et al., NOAA)



Methane gradient



TTL transit time calculations

COMPOUND	PPT/K	PPT/20K	LOSS	RESIDUAL PPT	NH TREND (PPT/mon)	**Months (360-380K)**
HCFC-141b	-0.016	-0.322	-0.086	-0.236	0.142	**1.7**
HCFC-142b	-0.010	-0.200	-0.084	-0.116	0.090	**1.3**
HCFC-22	-0.097	-1.936	-0.860	-1.076	0.565	**1.9**
HFC-134a	-0.062	-1.240	-0.256	-0.984	0.546	**1.8**
HFC-152a	-0.006	-0.120	-0.022	-0.098	0.040	**2.4**

AVERAGE = 1.8±0.4 month

Summary

- (Reasonably) successful deployment of new version Whole Air Sampler
- Identification of tropical air mass sources during RF02/03
- Examined chemical gradients of HCFC/HFCs to evaluate transport time scales thru TTL
- Additional correlations/gradients being examined

Future work/Plans

- Minor engineering adjustments
- Plans for on-site analysis
  - Likely no CO, CH4, N2O analysis,
    - Except last 4 flights of mission
- Comprehensive canister/pump conditioning + tests
- Need pump isolation/purging in hangar
- Improvements in flight operations/sampling